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Standards for Aerobic

With the drive for environmentally-friendly products worldwide, the use of "green" materials in product manufacture are being actively explored and marketed. ICMA has created its own Green Task Force, including a Greening of the Factory initiative and EcoLabel Standard Program. This program defines measurable criteria for assessing the environmental impact of cards for ICMA EcoLabel certification.

In order to show compliance with ICMA EcoLabel certification requirements at the "verified" level, an independent laboratory will need to conduct testing for compostability in accordance with the following published Standards:

- **ASTM D 5338,** Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions
- **ISO 14855-1,** Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide – Part 1: General method
- **ISO 14855-2,** Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide – Part 2: Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test
- **ISO 16929,** Plastics – Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test
- **ISO 20200,** Plastics – Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test
- **ISO 17088,** Specifications for compostable plastics

For those interested in manufacturing cards with more environmentally-friendly materials such as biodegradable PVC and bioplastics, this is a good list to help determine the degree of disintegration and biodegradation of these materials. While there is some overlap between these Standards, it is instructive to review the wide variety of test methods that exist to measure, evaluate and compare the biodegradation of any given material, once you have determined the appropriate disposal conditions and the associated microorganisms.

ASTM D 5338

This test method determines the degree and rate of aerobic biodegradation of plastic materials on exposure to a controlled-composting environment under laboratory conditions. This test method is designed to yield reproducible and repeatable test results under controlled conditions that resemble composting conditions. The test substances are exposed to an inoculum (microorganisms present in compost) that is derived from compost from municipal solid waste. The aerobic composting takes place in an environment where temperature, aeration and humidity are closely monitored and controlled. It is designed to yield a percentage of conversion of carbon in the sample to carbon dioxide. The rate of biodegradation is monitored as well. This test is also designed to be applicable to all plastic materials that are not inhibitory to the microorganisms present in aerobic composting piles.

Summary of the Test Method

- Selection of plastic material for the determination of the aerobic biodegradability in a controlled composting system
- Obtaining an inoculum from composted municipal solid waste, or alternatively, compost from plants, yard waste or mixtures of green waste and solid municipal waste
- Exposing the test substances to a controlled aerobic composting process in conjunction with the inoculum
- Measuring carbon dioxide evolved as a function of time
- Assessing the degree of biodegradability

Biodegradation Testing of Plastic Materials

The percentage of biodegradability is obtained by determining the percentage of carbon in the test substance that is converted to carbon dioxide during the duration of the test. This percentage of biodegradability will not include the amount of carbon converted from the test substance that is converted to cell biomass and that is not, in turn, metabolized to CO_2 during the course of the test.

ISO 14855 – 1: 2005 General Method

The main method specified in Part 1 of ISO 14855 uses a solid-phase respirometric test system based on mature compost used as a solid bed, a source of nutrients and an inoculum rich in thermophilic microorganisms. Mature compost is a very heterogeneous and complex material. Therefore it can be difficult to quantify the residual polymeric material left in the bed at the end of the test, to detect possible low-molecular-mass molecules released into the solid bed by the polymeric material during degradation and to assess the biomass. As a result, it can be difficult to perform a complete carbon balance. Another difficulty which is sometimes encountered with mature compost is a "priming effect": the organic matter present in large amounts in the mature compost can undergo polymer-induced degradation, (the "priming effect"), which affects the measurement of the biodegradability.

To overcome these difficulties and to improve the reliability of the method, the mature compost can be replaced by a solid mineral medium which is used as the composting bed, thus facilitating analyses. This variant can be used to measure the biodegradation in terms of CO_2 evolution, to quantify and analyze the biomass and the residues of polymeric material left in the solid bed at the end of the test, and to perform a complete carbon balance. Furthermore, the method is not sensibly affected by the priming effect and can therefore be used to assess materials known to cause this problem with mature compost. The mineral bed can also be subjected to an ecotoxicological analysis to verify the absence of any activity in the bed after biodegradation.

ISO 14855 – 2: 2007 Gravimetric Measurement of Carbon Dioxide Evolved in a Laboratory – Scale Test

ISO 14855 – 1 is a common test method that measures the amount of carbon dioxide evolved using methods such as continuous infrared analysis, gas chromatography or titration (volumetric analysis). Compared with ISO 14855 – 1, the amounts of compost inoculum and test sample used in this part of ISO 14855 are one-tenth the size. In order to ensure the activity of the compost inoculum, inert material that gives the mixture the same texture as soil is mixed into the inoculum. The carbon dioxide evolved from the test vessel is determined by absorbing it in a carbon dioxide trap and carrying out gravimetric analysis of the absorbent. The method described in this part of ISO 14855, which uses a closed system to capture the carbon dioxide evolved, can also be used to obtain valuable information, by means of isotopic-labeling studies, on the way in which the molecular structure of co-polymers degrade.

ISO 16929: 2002

Determining the degree of disintegration of plastic materials in a pilot-scale plant is an important step within a test scheme to evaluate the compostability of such materials. This Standard is used to determine the degree of disintegration of plastic materials in a pilot-scale aerobic composting test under defined conditions. It forms part of an overall scheme for the evaluation of the compostability of plastics as outlined in ISO 17088 (Plastics–Evaluation of

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Industry Standards, continued from page 27

compostability – Test scheme for final acceptance). The test method described in this Standard can also be used to determine the influence of the test material on the composting process and the quality of the compost obtained. It cannot be used to determine the aerobic biodegradability of a test material. Other methods are available for this test (e.g. ISO 14855).

The disintegration test is performed under defined and standardized composting conditions on a pilot-scale level. The test material is mixed with fresh biowaste in a precise concentration and introduced into a defined composting environment. A natural ubiquitous microbial population will start the composting process spontaneously and the temperature will increase. The composting mass is regularly turned over and mixed. Temperature, pH-value, moisture content and gas composition are regularly monitored. They have to fulfill certain requirements to ensure sufficient and appropriate microbial activity. The composting process is continued until a fully stabilized compost is obtained. This is usually the case after 12 weeks.

ISO 20200: 2004

The test method described in this Standard determines the degree of disintegration (but not biodegradability) of plastic materials when exposed to a composting environment. The method is simple and inexpensive, does not require special bioreactors and is scaled for use in any general-purpose laboratory. It requires the use of a standard and homogeneous synthetic solid waste. The synthetic waste components are dry, clean, safe products which can be stored in the laboratory without any odor or health problems. The synthetic waste is of constant composition and devoid of any undesirable plastic materials which could be erroneously identified as test material at the end of testing, altering the final evaluation. The bioreactors are small, as is the amount of synthetic waste to be composted (approximately 3L). With the limited amount of test material, this method provides a simplified test procedure. Since biodegradability is not determined with this test method, further testing will be necessary before being able to claim compostability.

While the above all describe various test methods, ISO 17088 provides the specifications for compostable plastic materials. In it can be found the basic requirement that 90% of the organic carbon (relative to a positive control sample) shall be converted to carbon dioxide by the end of the test period (not to exceed 180 days). Whatever method is used, these are long-term tests compared to card testing normally performed for other physical card characteristics. Advance planning is required if you intend to conduct such testing.